# Summary Report of the Iowa Text Reader Study 2005-2006

## Study Overview

In Iowa's ongoing attempt to find effective interventions to close the achievement gap between students with disabilities and their non-disabled peers, the second year of the Iowa Assistive Technology Text Reader Study was implemented during the 2005-2006 school year. A collaborative committee developed tools, professional development materials, and data collection analysis used in the Study. The Iowa Assistive Technology Text Reader Study (2005-06) compared student reading performance (fluency and comprehension) when they read controlled vocabulary passages with and without use of text reader software with embedded study skills. The design included descriptive and empirical measures.

Software, training and support were provided through the Iowa Department of Education, Bureau of Children, Family, and Community Services; Iowa Program for Assistive Technology (IPAT), Area Education Agencies (AEAs), Local Education Agencies (LEAs), and Kurzweil Education Systems Inc. During the 2005-2006 school year, training was provided to Assistive Technology contacts in the following areas:

- Use of Kurzweil 3000 with embedded study skills
- Curriculum-based measurement strategies
- Levels of Use interviews
- Stages of Concern implementation surveys (on-line)
- Teacher impact surveys
- Student impact surveys

Originally, 68 students attending rural or urban schools across the state of Iowa were selected for this study. The selection criteria were as follows:

- Students in grade six or grade seven
- Students with Individual Education Programs (IEP), demonstrating mild to moderate disabilities (Levels 1 or 2)
- Evidence of reading goals in the area of reading comprehension, reading fluency, or vocabulary
- Students scoring in the non-proficient range on the reading subtests of the Iowa Test of Basic Skills (below 40th percentile.)

From November 2005 to May 2006, data were gathered on 61 students (90%) meeting the above criteria. Attrition was due to students moving, failing to meet one of the criteria or local technical difficulties. Due to missing data on various other measures of the study, the total number included in various analysis was often less than the 61 students meeting the basic criteria for inclusion in the study. Of the 61 participating students: 72% were Level 1 students, 28% were Level 2 students. Forty-one were sixth graders (67%). Twenty were seventh graders (33%).

# Training

During the 2004-2005 Text Reader Study, the assistive technology contacts received a total of 24 hours of training in the research design, text reader software, and data collection strategies. For the 2005-2006 year, an eight-hour refresher training session was provided to the assistive technology contacts in the use of Kurzweil 3000 with embedded study skills, curriculum-based measurement strategies, Levels of Use interviews, Stages of Concern implementation surveys, teacher impact surveys, and student impact surveys. The assistive technology contacts then provided local training for the teachers and students who participated in the study.

# Data Collection

The Time Series Concurrent and Differential (TSCD) Approach (Smith, 2000) was used to study the enhanced performance of students using a text reader by comparing student comprehension on passages read with and without the text reader. The order of presentation was randomly varied.  These repeated measures over time with and without assistive technology should provide evidence of the impact and outcome of assistive technology use. The expectation would be that enhanced performance would be evident and the achievement gap would narrow.

For seventeen weeks students in two cohorts used Kurzweil 3000, a text reader with embedded study skills, to access reading in content curriculum such as social studies, science, language arts or other selected curricula. The first cohort used the text reader software during the second and third quarters of the school year.  The second cohort used the text reader during the third and fourth quarters of the school year.  The staggered start was intended to control for the time of the school year. Every other week student reading performance (fluency and comprehension) was measured. Students read controlled vocabulary passages with and without the use of text reader software with embedded study skills. The following data were collected.

### Reading Fluency and Comprehension Data

Reading data were collected on student reading fluency and reading comprehension on carefully matched Jamestown controlled vocabulary reading probes.  The paper and scanned probes were matched for reading difficulty as measured by the Flesch-Kincaid Readability Measures.  The reading difficulty of the sixth grade reading passages varied. The probes were sequenced from the 5.6 grade level to the 7.7 grade level on the print and scanned passages. The data were collected every other week using the reading passages by the assistive technology contacts.

### ITBS Scores

The Iowa Test of Basic Skills (ITBS) scores from 2003 – 2004 school year were used as baseline data in the domains of reading comprehension, vocabulary, and reading composite. These outcome measures will be collected for the 2004 – 2005 and 2005 - 2006 school years. These assessments are routinely administered either in the fall or spring at local district discretion. This process will provide longitudinal data regarding the impact on academic performance.

**Levels of Use Interview**

The Concerns Based Adoption Model (CBAM) tool Level of Use Interview, was used to monitor the implementation of the study during 2005-2006. The adapted tool, the Levels of Use Interview, was completed twice a month by local study implementers and their assistive technology contacts. This generated data on positive information and barriers of concern for implementing the text reader software. When this information was identified the assistive technology contact coached the implementer to problem solve issues of concern for using the text reader.

**Student and Teacher Digital Text Matrices**

The Student and Teacher Digital Text Matrices record student or teacher progress across a variety of domains. The Student Digital Text Matrix measures independent student use and school-wide use. The Teacher Digital Text Matrix measures knowledge and implementation of the software, accessibility, technology issues, and school-wide use. The matrices were designed to be able to monitor individual change as well as system change. The matrices were completed four times to include their reflected use and competency level for access and integration of text reader software with print learning tasks. Students worked with an implementer or an assistive technology contact to complete a Student Digital Matrix. They ranked their individual level of performance with independent navigation, frequency of access, and use of the text reader software with embedded study skills.

**Student and Teacher Impact Surveys**

Students and teachers completed impact surveys at the conclusion of each cohort. These surveys were completed using an online survey tool. They reported their subjective impressions of the implementation, satisfaction, and effectiveness of the text reader with embedded study skills.

## Summary of Results

**Reading Fluency and Comprehension Data**

Curriculum-based assessment strategies were used to collect student reading performance (fluency and comprehension) when the students read controlled vocabulary passages with and without the use of text reader software with embedded study skills. Progress was measured twice a month. Students read a 200-word passage from the sixth grade level of the Jamestown Reading Series. The reading difficulty increased from the 5.6 grade level to the 7.7 grade level on the print and scanned passages. For the purpose of study the passages were ranked and matched in order of ascending difficulty.

**Reading Fluency (words per minute)**

The fluency of students, as measured by words per minute, is shown in Figure 1.

**Figure 1**
**Fluency Comparing Paper and Scanned Presentation**
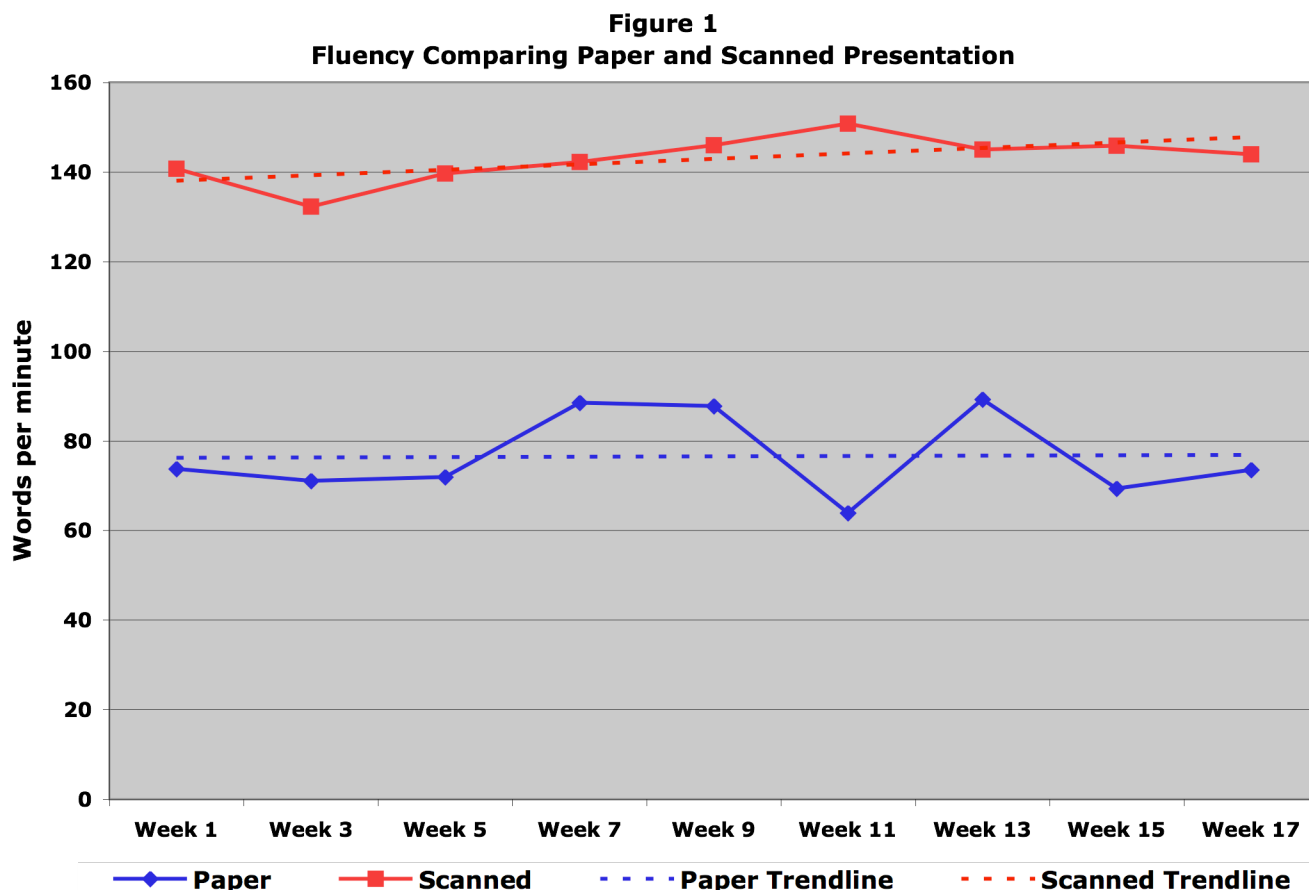


There was a very large difference between scanned and paper reading speeds. There was a slight increase in speed over the weeks of the study with scanned probes, and no change for paper probes. The trend line for the scanned text demonstrates a slight positive increase in the words read correctly per minute while the trendline for the paper text remained flat. This data demonstrated that students can access twice the amount of scanned text as print text in the same amount of time. This accommodation addresses the difficulty students have reading the quantity of assigned text in the typical classroom. While the passage difficulty increased from 5.6 to 7.7 in the 17 weeks, both groups maintained or slightly improved their reading fluency.

Fuchs, Fuchs, Hamlett, Walz, & Germann (1993) report that the realistic weekly improvement rate in reading fluency for sixth grade special education students is .3 words per week. This would predict a 5 word per minute increase in seventeen weeks of this study. As the figure above shows students maintained their reading fluency despite increased passage difficulty but no gains in reading fluency were observed on paper probes. The increased reading passage difficulty may have confounded the reading fluency results.

## Reading Comprehension

Performance of students on the reading comprehension probes, for both paper and scanned formats, can be seen in Figure 2.

**Figure 2**
**Accuracy, on Reading Probes, of Students Reading Comprehension**
**Comparing Paper and Scanned Presentation**
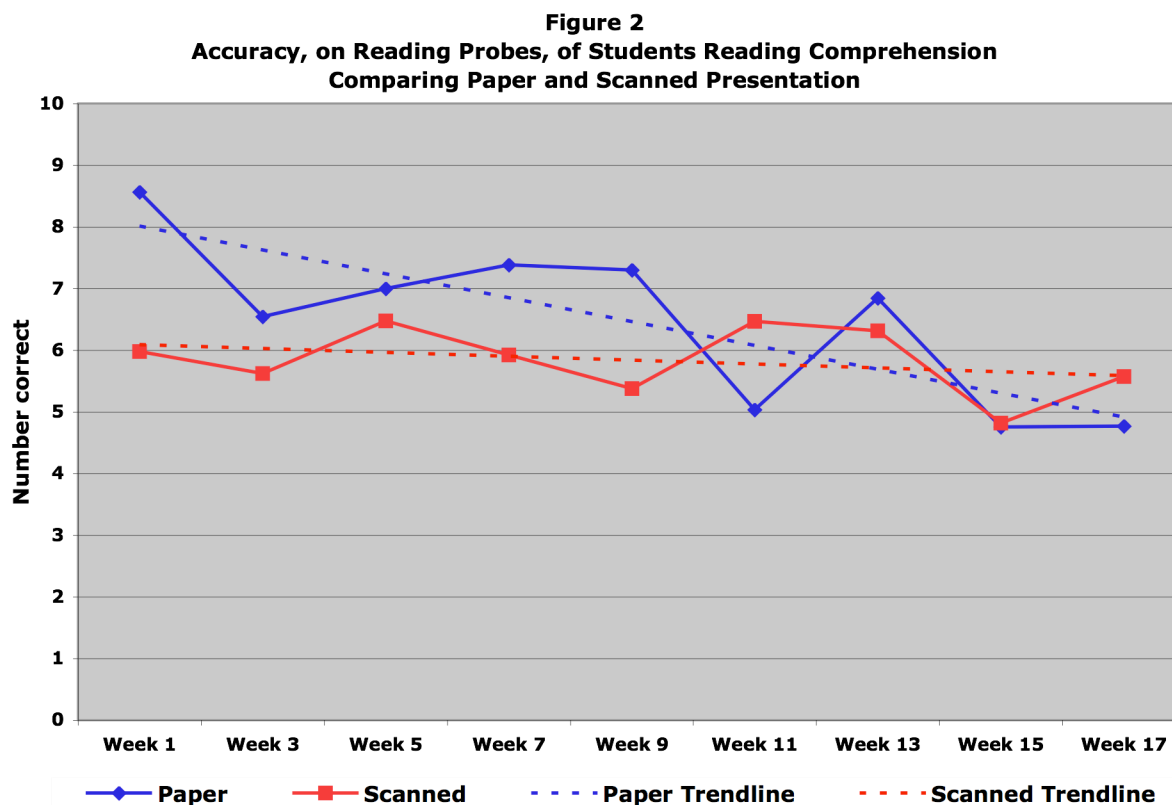


The readability of the reading passages, both print and scanned was matched and sequenced in order of increasing difficulty, from the 5.6 grade level to the 7.7 grade level. As can be seen in this figure, comprehension scores when students read print text, declined as the reading difficulty increased. When accommodated with the text reader software, the trend of reading comprehension scores remained relatively flat with only a slight decline, even though the reading difficulty continued to increase. The slopes indicate the diverging pattern of the trend lines. Performance was better initially for print text as compared to scanned text. However, by week eleven, as the students began to master the use of the text reader (see student digital text matrix scores) their comprehension trendline leveled off.

To look at whether the apparent difference between computer and paper format was statistically significant, a repeated measures analysis of variance was conducted on the difference scores (the difference for each participant, for each week, between their score on paper and computer presentation. The independent variable was the week of presentation (1, 3, 5, 7, 9, 11, 13, 15, 17), resulting in nine levels. This analysis was only conducted on the students who received both computer and paper probes for all 9 data points. There were a total of 27 participants who met these criteria. Their pattern of scores was very similar to the entire group of participants, as can be seen in Figure 3.

**Figure 3**
**Accuracy, on Reading Probes, of Student Comprehension**
**Comparing Paper and Scanned Presentation:**
**Students with no missing data**
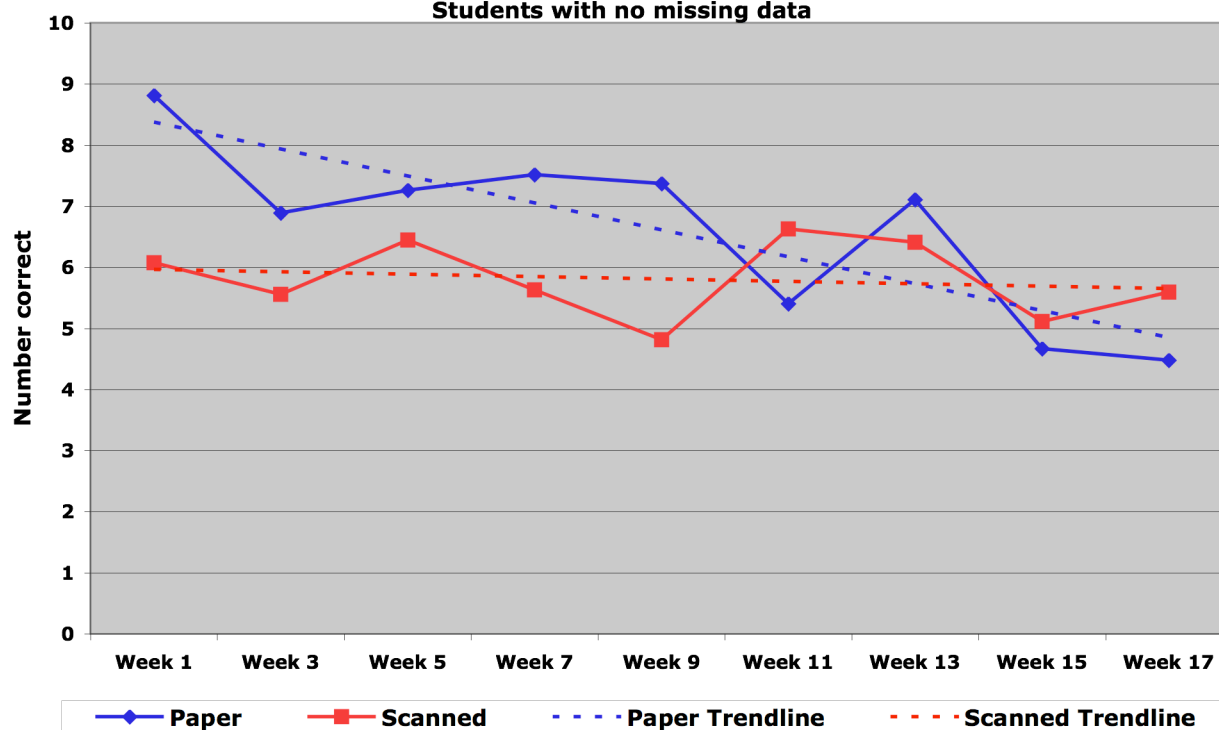
For each student, for each week, the difference between their score on computer and paper probes was calculated. The analysis of variance revealed that these difference scores changed over time, and the result was highly significant, $F(8, 208 = 15.37$, $p<.0001$, showing that this convergence of the functions over time was significant. The analysis of variance demonstrates that the two reading formats result in significantly different trends in student's reading comprehension scores. The comprehension scores for the print probes dropped 31 points from the 80% to 49%. The comprehension scores for the scanned probes dropped 4 points from 61% to 57% as passage difficulty increased.

The reason for the initial superiority of paper presentation is not clear, although this disappears by week 11. The data indicate there might have been an initial adverse effect on performance while students are learning to navigate the software. Week 11 seems to be the tipping point when students move from the acquisition process to the implementation process. With only 17 weeks of data, we are left to wonder if the trends would have continued to diverge.

Do students of different ability levels demonstrate better performance on paper or scanned probes? To answer this question, the sample was divided by ITBS national percentile rank scores in reading comprehension. The students were divided into two groups, one less than the 21st and one greater than the 20th percentile up to the 41st percentile (using whole numbers). Test scores from the 04-05 academic year were used. These scores are defined as non-proficient in Iowa. See Figure 4.
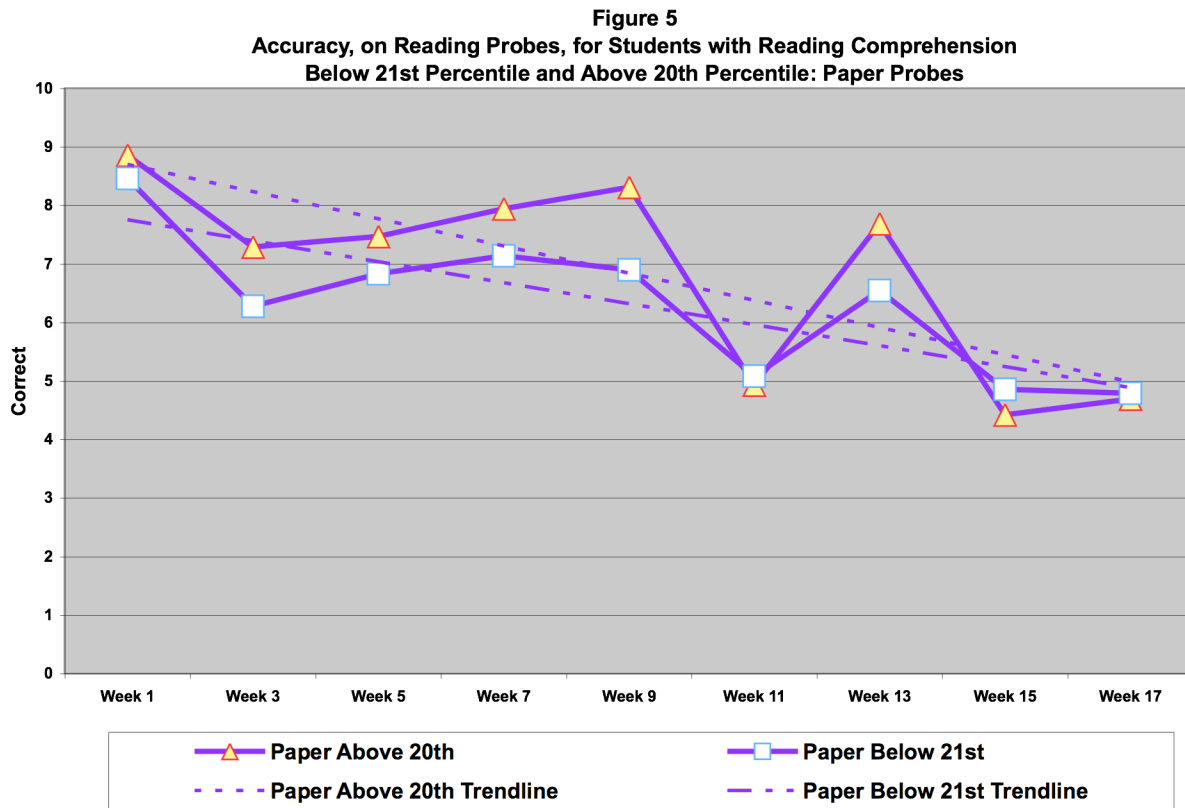
**Figure 4**
**Accuracy, on Reading Probes, for Students with Reading Comprehension**
**Below 21st Percentile and Above 20th Percentile: Paper and Scanned Probes**
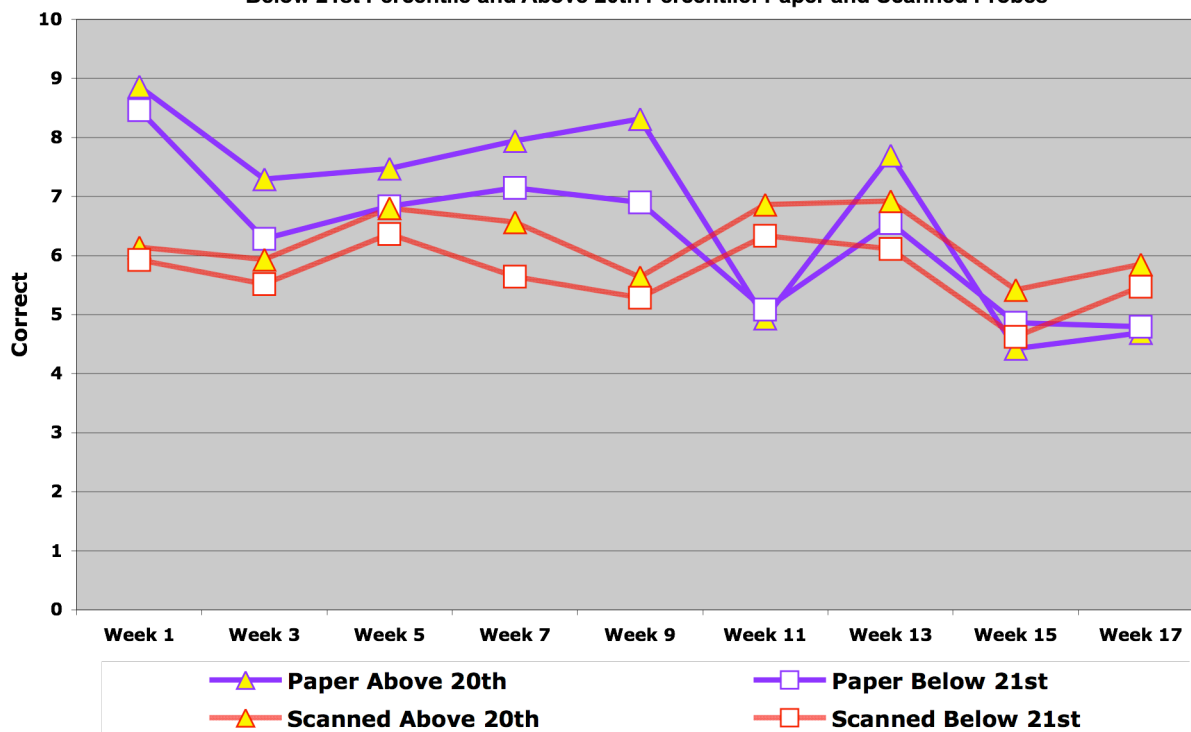
Through week 9, within ability groups, the students on paper probes scored higher than they did on scanned probes regardless of their ITBS reading comprehension scores. The reading performance for both groups indicates a tipping point at week 11. The reading scores of the students when accommodated with the text reader were higher on three of the four last data points.

In addition, correlations were conducted to look at the relationship between ITBS reading comprehension and accuracy on both paper and computer comprehension quizzes. For these analyses, the correlations are between the student's rank in reading comprehension and the average of their comprehension scores across the 17 weeks of the study. The correlation between ITBS reading comprehension and paper presentation was highly significant, $r(59\ df) = 0.345177614$, $p = 0.007418$. The correlation between ITBS reading comprehension and computer presentation was not significant, $r(59\ df) = 0.182141566$, $p = 0.167371$. Also, there was a very strong relationship between paper and computer presentation on the comprehension task, $r(59\ df) = 0.646324567$, $p < .0000001$. One explanation for the lack of correlation between ITBS reading comprehension and the computer presentation was that the text reader effectively mediated the effects of the disability.

Do students with higher or lower reading achievement scores respond differently to the use of text reader software? To examine this, the data was analyzed comparing performance using the text reader software for student scoring below the 21st percentile and above the 20th percentile. Figure 5 illustrates the pattern of scores on the paper comprehension quizzes for students scoring below the 21st and above the 20th percentile on the ITBS reading comprehension subtests.

**Figure 5**
**Accuracy, on Reading Probes, for Students with Reading Comprehension**
**Below 21st Percentile and Above 20th Percentile: Paper Probes**



On paper probes, students in both achievement groups show a negative trend with differences in comprehension quiz scores ranging from 0 to 12 points. Their performances paralleled each other.

Figure 6 illustrates the pattern of scores on the scanned comprehension quizzes for students scoring below the 21st and above the 20th percentile on the ITBS reading comprehension subtests.

**Figure 6**
**Accuracy, on Reading Probes, for Students with Reading Comprehension**
**Below 21st Percentile and Above 20th Percentile: Scanned Probes**
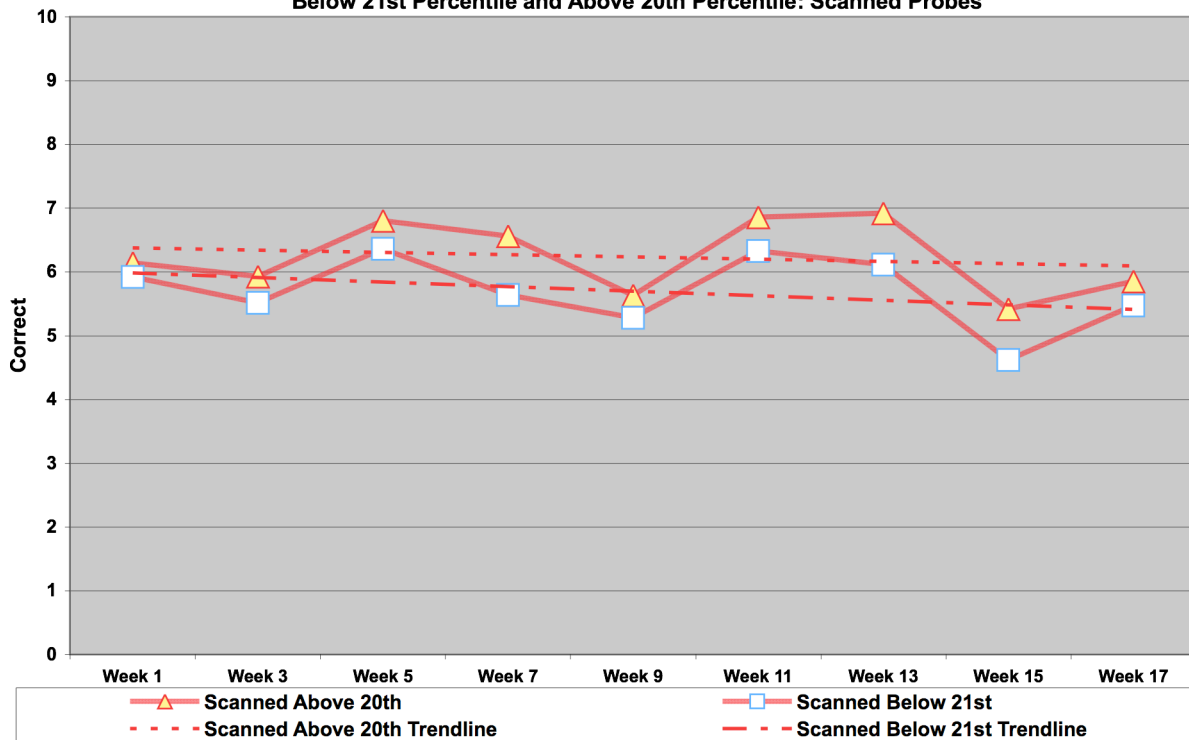


On scanned probes, students in both achievement groups show a relatively flat trendline even as the reading passage difficulty increased. As would be expected the students with higher achievement scores did better on the scanned reading quizzes. Again, their performances paralleled each other. However, in comparison to the paper probes, the gap between the two achievement groups is much narrower when accommodated with the text reader software. Instead of the 39 percent drop seen on the paper probes, the drop of comprehension scores on scanned probes was 2 percent.

## ITBS scores

Forty-three out of 60 participants had ITBS scores recorded for both years. Twenty participants (47%) moved to higher percentile rankings, 5 participants (12%) remained the same, and 18 participants (41%) moved to lower rankings. It should be noted that if a student maintained their percentile ranking on the next higher grades assessment the student has increased their grade equivalency by one year and maintained their academic competency at that level.

## Levels of Use Interview

Every other week as part of the assistive technology contacts' consultation with the district staff, the Levels of Use Interview was completed. The resulting data demonstrated a developmental pattern moving from low level of use (red and orange) to highly collaborative stages of use (green and blue). In some cases, resistance to implementation due to time management and technical issues were apparent. See Figure 7.

**Figure 7**
**Level of Use Interview**
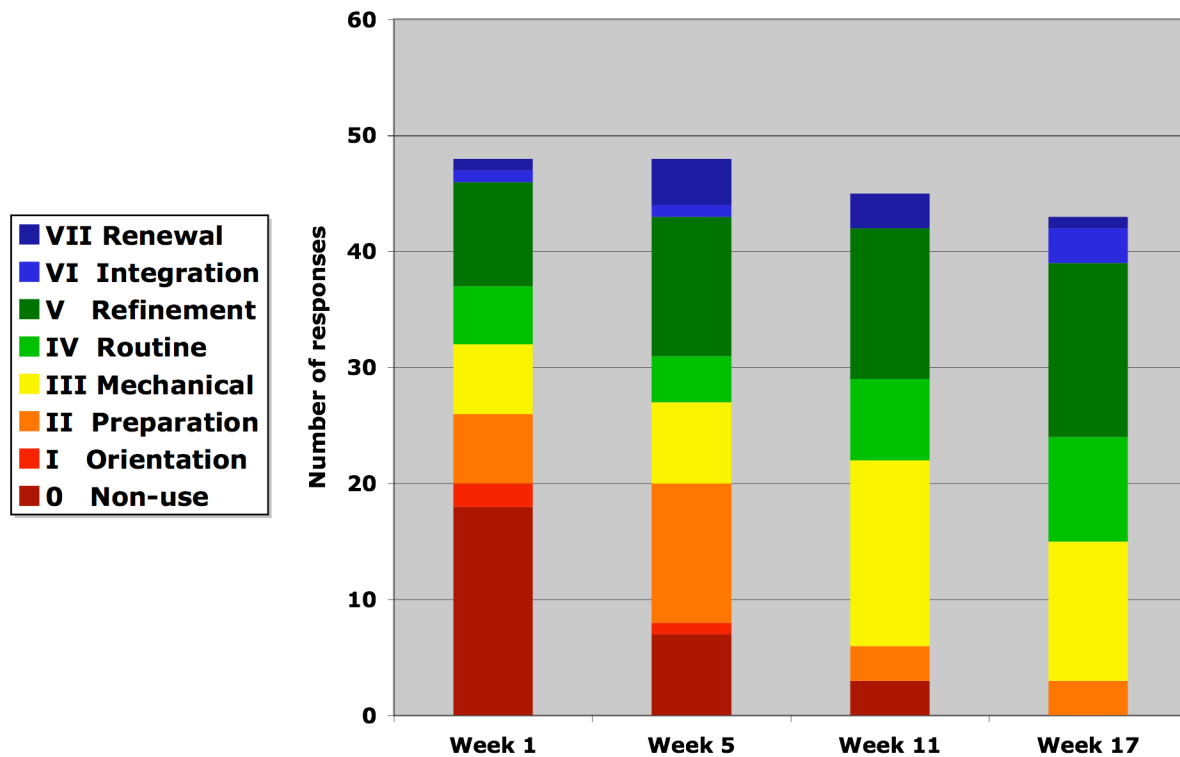


The resulting data (Figure 7) demonstrated a developmental pattern moving from low level of use (0) Non Use –dark red, (I) Orientation – red, (II) Preparation - orange, (III) Mechanical – yellow, to highly collaborative stages of use (IV) Routine – light green, (V) Refinement – Dark green, (VI) Integration – royal blue, and (VII) Renewal – dark blue.  In some cases, resistance to implementation may be attributed to time management and technical issues within the environment.  During year 2005-2006 the training was compressed from 24 hours to 8 hours. This factor influenced the pattern of implementation. It should be noted here that the level of Non-Use (dark red) diminished in week 5 however was still reported in week 11. A need for Orientation (red) was evident in weeks 1 and 5. It was no longer an issue for implementation by week 11. Preparation (orange) level of use was an implementation skill by teachers that over time of decreased as the materials were scanned and edited for student use. The mechanical level of use was an indicator of how fluid the use of the text reader software was used in the classroom.  Often at this level of use the infrastructure plays a part in the ability of the system to accommodate the time and environmental space to allow for smooth student access. As can be seen in Figure 8 by week 11 there is less focus on preparation and more emphasis on mechanical use with in the classroom. In conjunction with the analytical data at week 11 there is also a positive change in student performance.  This begs the question, "At what level of use do teachers need to function to impact student performance with the text reader?"

**Figure 8**
**Levels of Use Interview**
**Non-Use through Mechanical combined, Routine through Renewal combined**
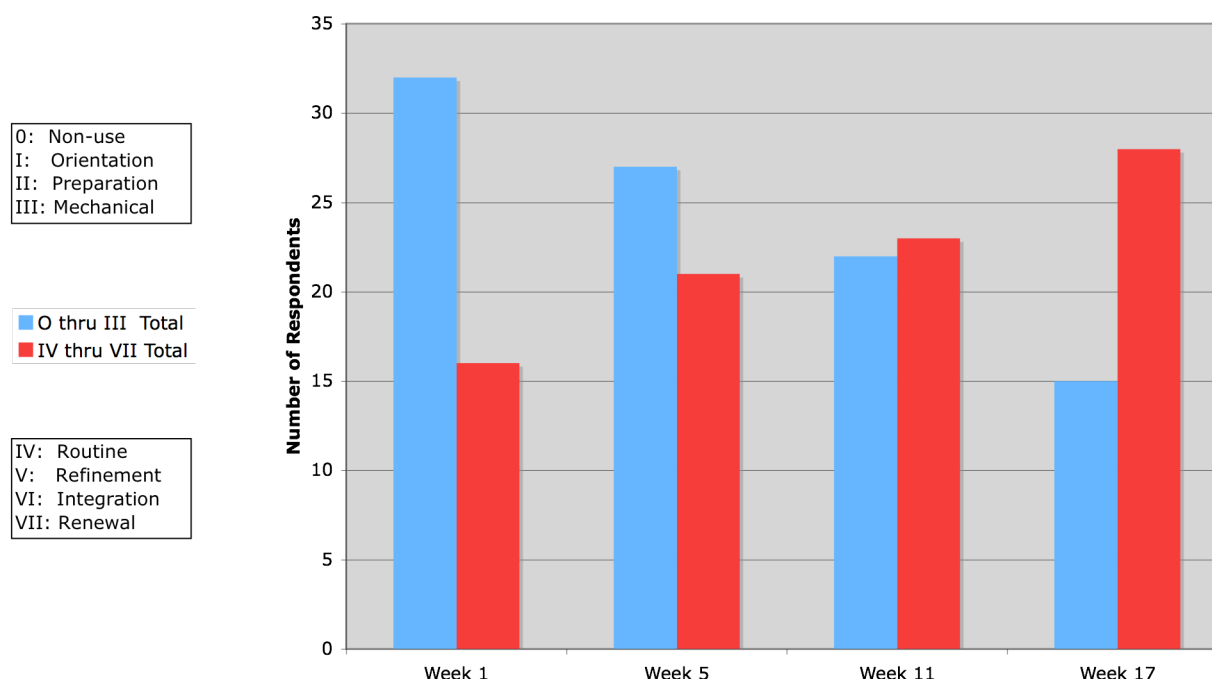


To answer this question, correlations were conducted between scores on the Level of Use and a Digital Text Innovation Matrix at weeks 1, 5, 11, and 17 and the student's performance on those weeks. There was a highly significant negative correlation between level of use and the percent of questions correct for paper presentation, $r(192 \text{ d.f.}) = -0.242155479$, $p=.0007$. The correlation between level of use and computer presentation, while negative, was non-significant, $r(188 \text{ d.f.}) = -0.134318729$, $p=.0661$. It was felt the sequence of increased reading difficulty of the probes confounded the interaction between level of use and comprehension.

Note: Although Level of Use is ordinal in nature, the fact that the number of levels is greater than 4, and the large sample size suggest that the use of the Pearson correlation coefficient would still be appropriate. For additional information, see:
- http://www.statsoft.com/textbook/stnonpar.html
- Johnson, D.R., & Creech, J.C. (1983) Ordinal measures in multiple indicator models: A simulation study of categorization error. *American Sociological Review, 48*, 398-407.

Zumbo, B.D., & Zimmerman, D.W. (1993). Is the selection of statistical methods governed by level of measurement? *Canadian Psychology, 34,* 390-400.

## Student and Teacher Digital Text Matrices

As the weeks went forward during the study the raw scores of each matrix appeared to increase in the area of school-wide access. However, the level of student independence using the software did not increase to a level that would allow fluid use of the software in all core content areas. On the teacher matrix only a few of the respondents rated themselves as using the text reader with a high rate of collaboration. A few of the teachers maintained the level of use of management and did not move forward after week 5. The rest of the teachers were able to use the software at the routine or refinement level of use by week 11 in the 17-week time frame.

The second measure of how the text reader was being implemented was through the Student Digital Text Innovation Matrix. The correlation between this measure and the percent of questions correct for paper presentation was negative and highly significant, $r(194 \text{ d.f.}) = -0.35035191$, $p<.0001$. There was no correlation between the score on the Digital Text Innovation Matrix and the percent correct using computer presentation, $r(192 \text{ d.f.}) = -0.022493502$, $p= 0.7568$. This data will be further analyzed for the specific significance of different pattern between the two groups.

**Student Impact Survey**

At the end of their intervention cohort, thirty-two students (52%) completed an online survey assessing their impressions of the project and the impact of the text reader software on their access to the general education curriculum. The survey of the results shows a generally positive view of the text reader.

| | |
|---|---|
| 91% | liked the software. |
| 91% | thought it was pretty easy or very easy to learn. |
| 91% | reported it helped them with their schoolwork. |
| 100% | thought it helped them with their reading. |
| 85% | reported it helped them stay on task. |
| 97% | reported it helped them work better independently. |
| 84% | reported it helped them earn better grades on tests. |
| 52% | reported it helped them have better attendance at school. |
| 87% | reported it helped them feel better about themselves. |
| 94% | reported it helped interest them in what they were learning. |
| 94% | reported it helped them understand what was written in their books. |
| 87% | reported it helped them get their work done. |
| 71% | reported it improved how well they wrote. |

When asked, " How else has the Kurzweil text reader software helped you?" students commented that it helped them complete their homework, catch up in class, made schoolwork more interesting, helped them understand their work, helped them stay in class instead of leaving to take tests, and helped bring up their reading and science grades.

**Social Behavioral Data**

The students attribute many positive outcomes to the use of the text reader software. Objective data showed a mixed pattern in absences, tardies, and office referrals.  This will not be complete until post-study data are collected during 06-07.  Table 1 shows the median numbers of each for the 04-05 and 05-06 school years, and the number of students showing positive change, negative change, or no change.  The total number for each is reduced due to missing data.

**Table 1**
**Student absences, tardies, and referrals**

|  | Absences (n = 41) | Tardies (n = 44) | Referrals (n = 31) |
|---|---|---|---|
| 04-05 Baseline median | 6.25 | 1 | 0 |
| 05-06 Median score | 6.5 | 1 | 1 |
| Percentage with positive change | 60 | 46 | 18 |
| Percentage with negative change | 32 | 33 | 48 |
| Percentage with no change | 8 | 21 | 35 |

Although there was little change in median numbers, some changes did occur for individual student absences, tardies, and referrals. The improvement in absences and tardies are consistent with the student report on the survey. However, these changes are difficult to interpret, since many other factors could be have affected the results.

**Teacher Survey**

Twelve teachers (55%) completed the online survey assessing their impressions of the Study and the impact of the text reader software.
  92%  liked using the Kurzweil text reader.
  75%  said it was easy to use.
  25%  thought it was somewhat difficult to use while none said it was very difficult to use.
 100%  reported it helped their students read.
 100%  reported it helped their students stay on task.
 100%  reported it helped their students work independently.
  75%  reported it helped their students get better grades on tests.
  42%  reported it increased attendance at school.
 100%  reported it helped students feel better about themselves.
  92%  reported it improved students' interest in what they are learning.
 100%  reported it helped students understand what is written in their books.
  87%  reported it helped students complete their work.
  42%  reported it helped students improve how well they wrote.

When asked advantages and disadvantages of participating in this study, they commented positively on receiving the software and training, the variety of study skills which met students' learning styles, and the acquisition of an additional learning tool. Teachers commented on how

much the students loved working on the program.  They had reluctant readers who were finishing books for the first time. They appreciated the self-reflection the program initiated with the students.   Concerns expressed focused on the time commitment of scanning and editing the text and technical problems setting up the system within their districts.

# Discussion

This study demonstrated a notable finding that students can access twice the amount of scanned text as print text in the same amount of time when using text reader software.  This accommodation addresses the difficulty students have reading the quantity of assigned text in the typical classroom. Also, while comprehension scores for print text declined as the reading difficulty increased, comprehension scores for scanned text remained consistent, even though the reading difficulty continued to increase. The diverging pattern of the comprehension scores was highly statistically significant. Performance was better initially for print text as compared to scanned text. However, by week eleven, as the students began to master the use of the text reader their comprehension rates improved. The comprehension scores for the print probes dropped 31 points from the 80% to 49%. The comprehension scores for the scanned probes dropped 4 points from 61% to 57% as passage difficulty increased. In other words, when the students used the text reader to access the curriculum materials at twice the rate, they were able to maintain their comprehension levels.

When the relationship between ITBS reading comprehension and accuracy on both paper and computer comprehension was examined, a significant negative relationship was found between ability levels and paper presentation while it was not significant for levels of ability and computer presentation. One explanation for the lack of correlation between ITBS reading comprehension and the computer presentation was that the text reader effectively mediated the effects of the disability.  When performance was examined, the reading performance for both groups indicates a tipping point at week 11, when students move from the acquisition process to the implementation process.

On paper probes, students in both achievement groups show a negative trend with differences in comprehension quiz scores ranging from 0 to 12 percentage points.  Their performances paralleled each other. On scanned probes, students in both achievement groups show a relatively flat trend line even as the reading passage difficulty increased.  As would be expected the students with higher achievement scores did better on the scanned reading quizzes.  Again, their performances paralleled each other.  However, in comparison to the paper probes, the gap between the two achievement groups is much narrower when accommodated with the text reader software.  Instead of the 39 percent drop seen on the paper probes, the drop in comprehension on scanned probes was 2 percent.

In action-based research there are many factors that influence the pattern of implementation. The Level of Use Interview data indicated that most teachers in the study achieved the mechanical level of use of the software. There also appears to be a tipping point for teachers at week 11 when the majority of teachers move beyond mechanical use.  They were less focused on preparation and concerns with mechanical issues in the environment and were able to increase routine and refined use of the software. In conjunction with the analytical data at week 11 there is also a positive change in student performance.

Surveys reported very positive subjective responses from the students and teachers implementing the text reader study. Positive outcomes they associated with the use of the text reader software included improved academic performance, better on task behavior, more engagement in the instructional materials, and improved independent work completion.

The experience of the Iowa Text Reader Study highlighted the successes and difficulties of conducting state-wide action-based research. The training demands, the technological difficulties, and level of coaching needed to maintain the study's integrity proved very challenging. While the study reflects accurately the experience of anyone implementing new technology in the classroom, the difficulties raise concern about the integrity of the data. The difficulties included district technology problems that interfered with implementation, students moving, and problems with priorities of some teachers and assistive technology contacts. All these issues are being taken into account in developing the study design for the longitudinal work during the 2006-2007 study.

## Summary

Sixty-one students from across the state of Iowa participated in a 17-week study of the impact of the use of a text reader software program on multiple measures of academic performance. The Time Series Concurrent and Differential (TSCD) Approach (Smith, 2000) was used to study the enhanced performance of students using a text reader by comparing student comprehension on passages read with and without the text reader. The order of the reading format (print vs. scanned) of the probes was randomly varied. The repeated measures over time with and without assistive technology were used to provide evidence of the impact and outcome of assistive technology use. Enhanced performance was observed in the following areas:

- The ability to access twice as much information with consistent comprehension levels
- The maintenance of comprehension and speed with text reader software even as the reading difficulty increased
- The student move to more fluid use after eleven weeks of experience with the text reader.
- The gap between the two ITBS achievement groups is much narrower when students were accommodated with the text reader software. Instead of the 39 percent drop seen on the paper probes, the drop in comprehension on scanned probes was 2 percent.

Both the students and teachers participating reported strong positive feelings on feedback surveys linking the use of the text reader to a variety of positive school behaviors. Areas for further study were identified.

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**We wish to pay our respects to Roger Rachow (AEA 13). Roger was a pioneer in the field of Assistive Technology in Iowa and the primary motivator for this Study. Without his insights and experience with text readers, the Study would not have moved forward at the pace it did nor garnered the results it did. Roger was first and foremost and an advocate for children with disabilities. We will miss him. He passed away in June of 2005.**

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*Disclaimer:*
*While software, training and support were provided through the Iowa Department of Education, Bureau of Children, Family, and Community Services; Iowa Program for Assistive Technology (IPAT), Area Education Agencies (AEAs), Local Education Agencies (LEAs), and Kurzweil Education Systems Inc., this study was the independent work of Iowa Assistive Technology Liaisons.*